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Dike intrusion process at the eastern coast of Izu-Peninsula occurring in December 2009

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Earthquake swarm occurring at the eastern coast of Izu Peninsula is definitely caused by magma intrusion, because hypocenters migrates upwards in narrow pipe-like region, and then spreads outward from the center of the swarm activity whose depth is around 5 kilometers. The focal mechanisms of the earthquakes are oblique to the plane on which hypocenters align. It is coincide with the theoretical model that the intruded magma creates stress concentration at the tip of the dike and earthquakes are generated there. Since the observation systems were renewed in 1998, the precision of hypocenters are increases and the image of the dike intrusion becomes more clearly. In our previous studies, we revealed that the magma intrusions are classified into two groups. One is the dike that settles at the depth from 3 to 7 kilometers, and the depth of neutral buoyancy is presumed around 4.5km. The other does at the depth of 10 to 8 kilometers. All dike intrusions over at least 20 years, regardless of the neutral buoyancy depth, align on the unique plane whose dip angle is 70 degrees. It represents that the dike spread on the plane whose normal direction is minimum principle stress. The latest activity started on December 17 in 2009 and lasted during several days. We determine shape of the dike from precise hypocenters and find out that the activity has significant feature comparing the previous activities.
In order to estimate precise magma migration image from the hypocenters, the uniformity of data set is very important. We pick up onsets from seismograms that are often overlapped by a few events and estimate hypocenters for the almost all events with magnitudes greater than 1. The features of the activity in December 2009 are almost common to the activities that have occurred in this area expect that the plane on which most earthquakes occur is nearly vertical. The systematic analysis on hypocenter distribution for the previous activities and the latest one shows that hypocenters of the previous activities are aligned on the unique plane but the latest activity are aligned on the different plane. In the latest activity, the seismic activity is grossly divided into three activities. The first sub-activity is the upward migration from 8 to 6km in depth. The second one is the upward migration from 6 to 4.5km (neutral buoyancy level) in depth. The third one is outward migration on the vertical plane. In the first sub-activity, hypocenters align on the unique plane on which hypocenters of the previous activities have been located. However, the hypocenters in the second and third sub-activity do not distribute on the unique plane. It may represent that magma started to intrude in a pre-existing pathway dipped 70 degrees from the horizontal plane, and it changed the intrusion direction and creates the new dike that has never intruded previously. The above hypothesis is supported that the seismicity is very high comparing with the volume of the intruded dike in this region.
In conclusion, we can present the following scenario. The magma has intruded on the unique plane repeatedly because the normal to the plane coincides with the direction of the minimum tectonic stress. After many repeated intrusion processes, the stress condition is changed and magma begins to intrude in the other plane during the latest activity. The activity on December 2009 is the onset of the new intrusion process. We may forecast that next coming magma will intrude in the vertical plane that created by the latest activity.
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